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EVALUATION OF A DUAL-CHAMBER, SPARK-IGNITION, TWO-STROKE ENGINE

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Environmental Protection Agency
Ann Arbor, Michigan

March 1972

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16. Abstracts

An evaluation was conducted of a two-stroke small displacement engine for which modifications had been developed. The test vehicle used was a 1967 Saab equipped with a manual four-speed transmission. The vehicle has a three cylinder, 49.6 CID engine with oil injection. The engine was modified by replacing the stock cylinder head. A hot start 1972 Federal Emission Test Procedure and a cold start 1975 FTP were performed on the vehicle. Bag samples were analyzed for hydrocarbon, carbon monoxide, carbon dioxide, and nitrogen oxides. Steady state cruise emissions were collected in CVS bags at 20, 30, 40, and 50 miles per hour. Results are tabulated. While the system does exhibit very low carbon monoxide and oxides of nitrogen levels, the excessive hydrocarbon levels indicate that a major modification to the system would be necessary to approach 1976 Federal emission standards.

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Carbon monoxide
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17b. Identifiers/Open-Ended Terms

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Federal Emission Test Procedure (1972)
Federal Emission Test Procedure (1975)

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Background

The Dynatech Corporation of Cambridge, Massachusetts developed modifications for a two-stroke small displacement engine. Because of this unique approach and little experience with evaluating two-stroke systems, the Test and Evaluation Branch scheduled a brief evaluation of the system.

Vehicle Tested

A 1967 Saab equipped with a manual four-speed transmission was used in the test program. The vehicle has a three cylinder, 49.6 CID engine with oil injection. The engine was modified by replacing the stock cylinder head. The replacement head provided a divided chamber configuration wherein each cylinder has a precombustion chamber connected to the main chamber by an orifice. The fuel delivery system utilized was a low pressure direct injection into both the prechamber and main chamber. The injection rate to the prechamber was constant while that to the main chamber was variable. The injection was electronically controlled and air inlet was unthrottled. The fuel used was JP4. A spark ignition system was used. In addition, the vehicle was equipped with a PTX-4 catalytic converter.

Test Program

A hot start 1972 Federal Emission Test Procedure and a cold start 1975 FTP were performed on the vehicle. Details of these constant volume sampling techniques are presented in the November 10, 1970, and July 2, 1971, Federal Register. Bag samples were analyzed using a flame ionization detector for hydrocarbon, nondispersive infrared analyzer for carbon monoxide and carbon dioxide and a chemiluminescent analyzer for oxides of nitrogen.

In addition to these tests, steady state cruise emissions were collected in CVS bags at 20, 30, 40 and 50 miles per hour. These bags were analyzed in a similar fashion to the previous tests. A flame ionization detector with heated sample lines was used to monitor continuous dilute hydrocarbon levels during these cruises. Use of this instrument enables measurement of the heavy hydrocarbons associated with the JP4 fuel used which could otherwise condense out and be missed during bag analysis.

Results

All of the data compiled during the evaluation is presented in the Appendix of this report. As the cold start 1975 FTP data indicates, the vehicle emitted very low levels of carbon monoxide (3.6 grams per mile) and oxides of nitrogen (.3 grams per mile). The carbon monoxide level is slightly higher than that allowed by 1975-76 Federal standards. The oxides of nitrogen level was below the 1976 requirement. Hydrocarbon levels of the Saab were quite high. These levels significantly exceeded current Federal requirements.

A comparison of steady state emission levels of the Saab versus two production vehicles is also presented in the Appendix. This data indicates an appreciable level of heavy hydrocarbon materials due to the oil injection and JP4 fuel. Again, this data shows very low relative carbon monoxide and oxides of nitrogen emissions.

Conclusions

While the system does exhibit very low carbon monoxide and oxides of nitrogen levels, the excessive hydrocarbon levels indicate that a major modification to the system would be necessary to approach 1976 Federal emission standards. If a modification of the system could be made, this engine configuration could be considered as a potential low emission power source.

APPENDIX

Emission Data
Dynatech Saab

1972 Federal Test Procedure
Hot Start

HC*	CO	CO_2	NOx
5.6 gpm	3.3 gpm	429 gpm	.3 gpm

1975 Federal Test Procedure
Cold Start

HC*	CO	CO_2	NOx
6.4 gpm	3.6 gpm	430 gpm	.3 gpm

* These hydrocarbon results were obtained using FID bag measurement. It is assumed that the figures are about 30% low due to heavy hydrocarbon condensation.

Emission Data
Dynatech Saab

Hot Steady State Bag Samples

		Saab	1971 Ford (351 CID)	1970 Datsun (97 CID)
20 mph	HC	6.9 gpm	1.2 gpm	1.9 gpm
Hot FID	HC	9.6 gpm	---	---
	CO	1.1 gpm	2.9 gpm	20.3 gpm
	NOx	.3 gpm	2.4 gpm	2.5 gpm
30 mph	HC	2.8 gpm	1.2 gpm	1.7 gpm
Hot FID	HC	4.4 gpm	---	---
	CO	.8 gpm	2.3 gpm	11.2 gpm
	NOx	.1 gpm	3.1 gpm	3.3 gpm
40 mph	HC	2.3 gpm	1.2 gpm	1.6 gpm
Hot FID	HC	4.1 gpm	---	---
	CO	1.0 gpm	2.5 gpm	6.0 gpm
	NOx	.1 gpm	7.1 gpm	4.2 gpm
50 mph	HC	2.0 gpm	1.2 gpm	1.8 gpm
Hot FID	HC	2.7 gpm	---	---
	CO	1.0 gpm	4.2 gpm	2.3 gpm
	NOx	.2 gpm	9.0 gpm	7.6 gpm